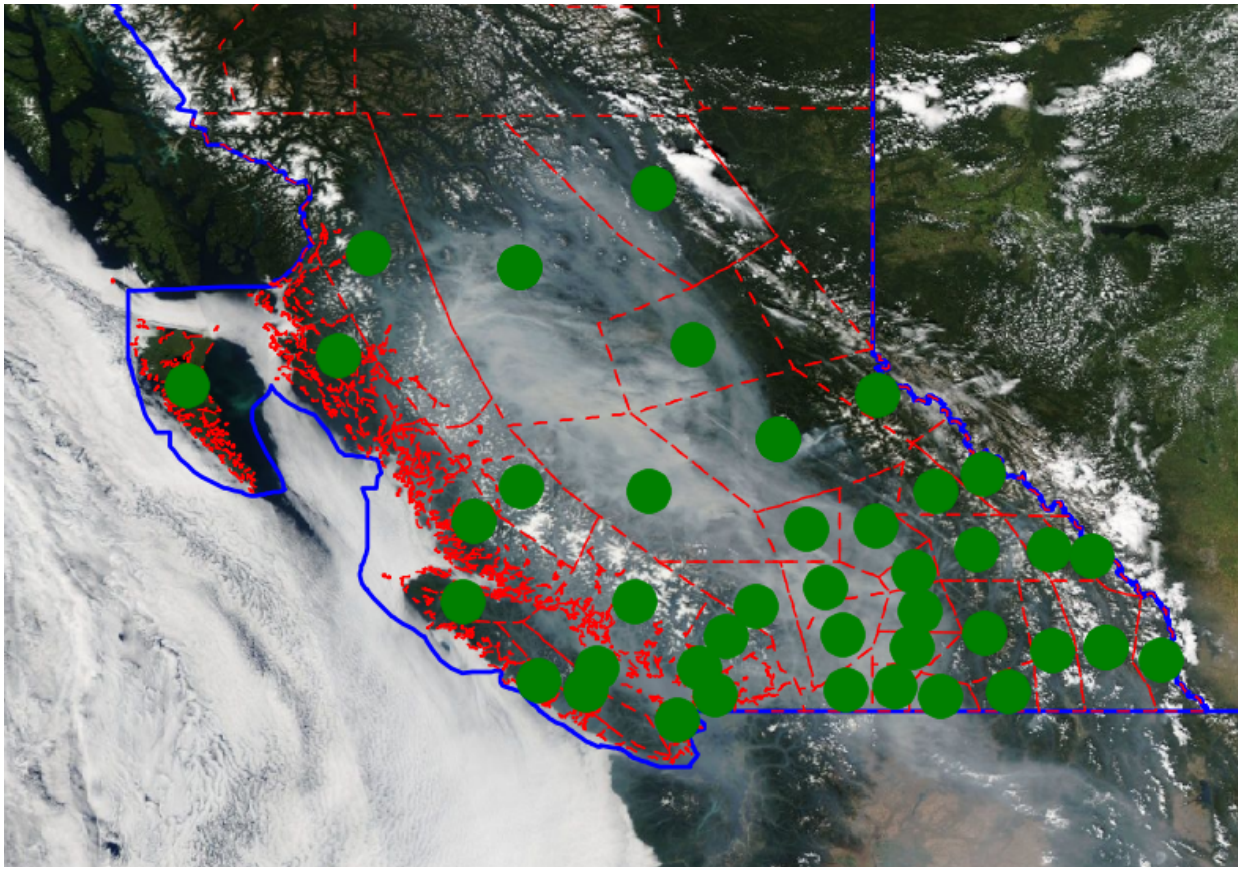


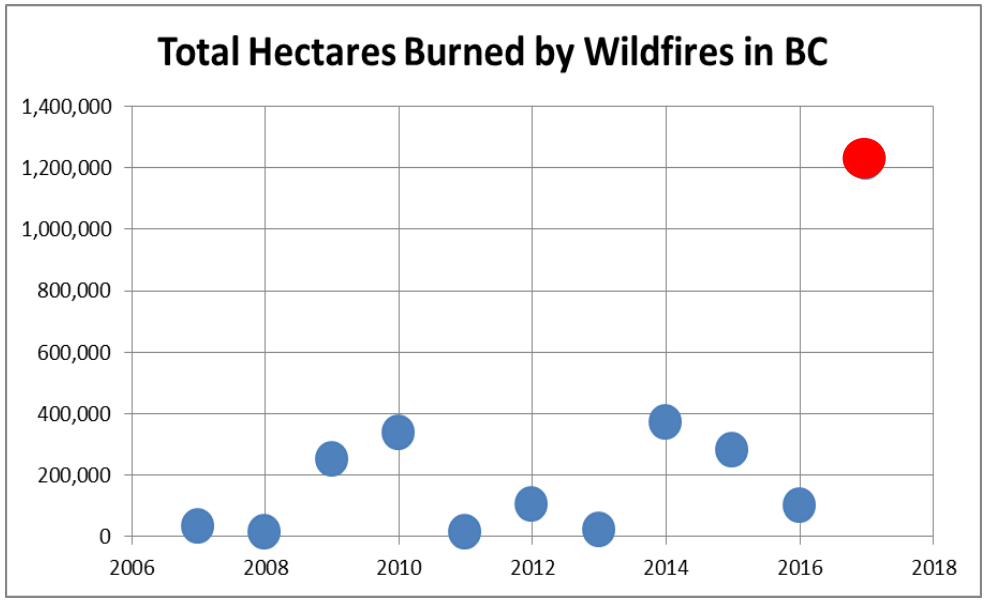
ECCC's Forest Fire Smoke Model (FireWork): New Configurations, User Survey Results and Retrospective Analysis of the 2017 BC Wildfire Season

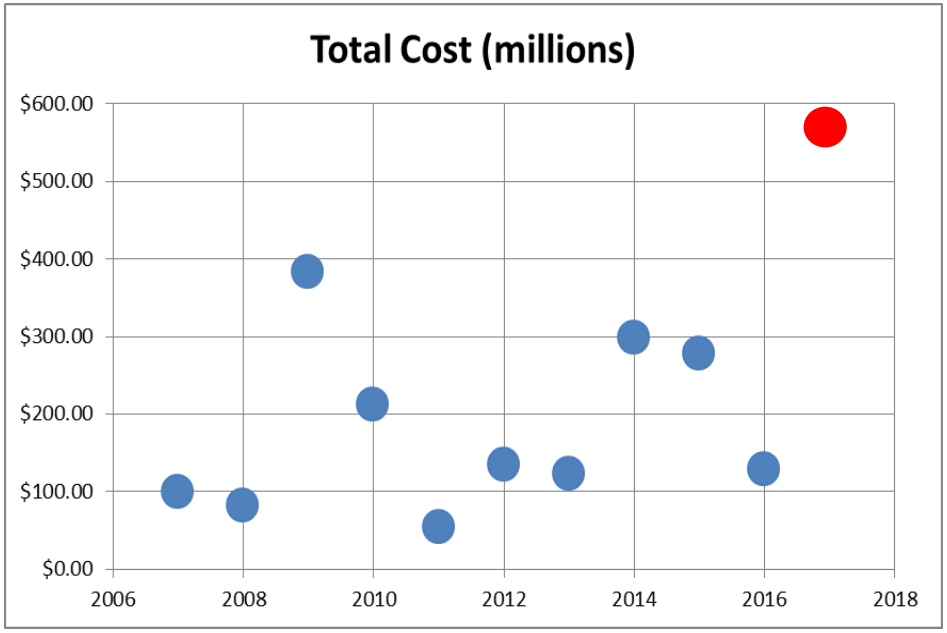
Bruce Ainslie and Rita So

NW - AIRQUEST 2018 Annual Meeting
June 14 , 2018

Overview

- Air Quality Science Unit, **Prediction Services Operations West** , Meteorological Services of Canada, Environment and Climate Change Canada
- AQHI (GEMMACH) and forest fire smoke plumes (**FireWork**)
- **2017** wild fire season in British Columbia
- How do forecasters **use** of model output?
- **User survey**
- **Model evaluation**
- New model **configurations** and retrospective analysis



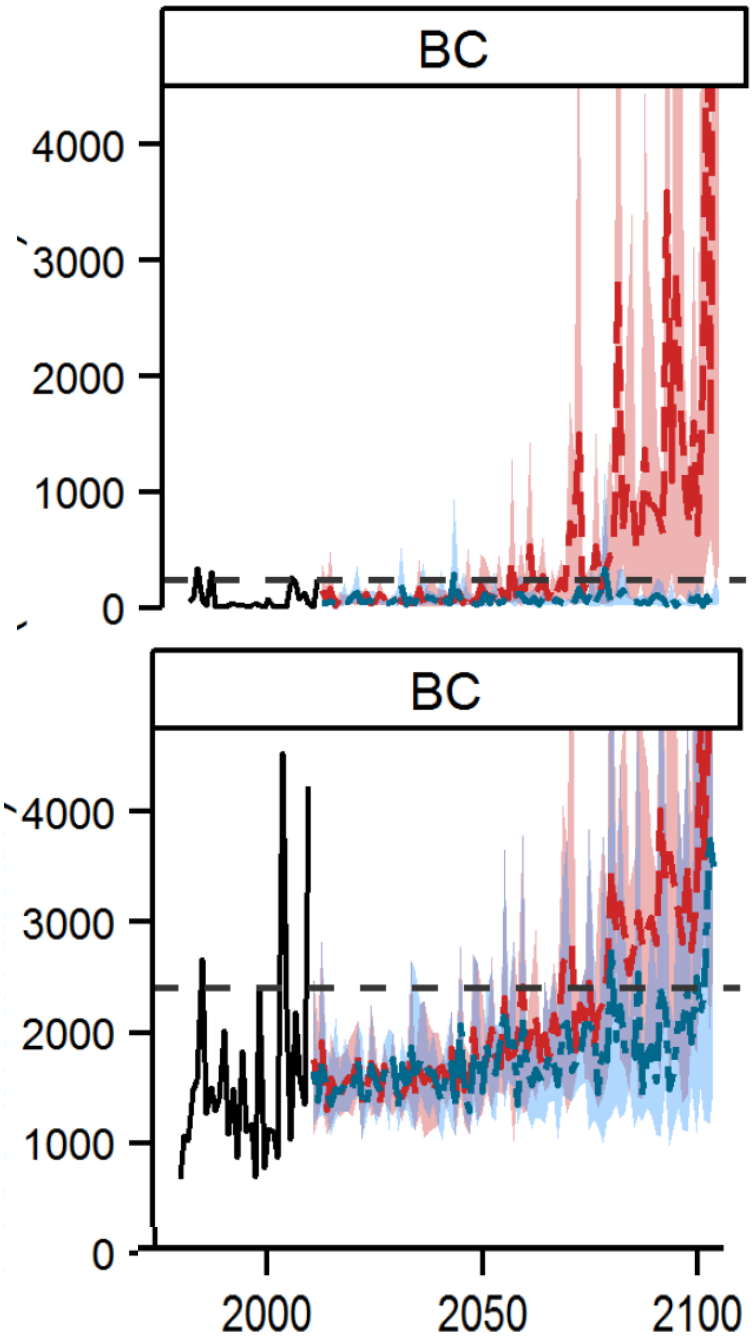


2017 wildfire season was exceptional:

- Over 1.2 M ha. burned
- Fire fighting costs exceeded $568 M
- Over 65,000 people evacuated

Source:https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-statistics/wildfire-averages

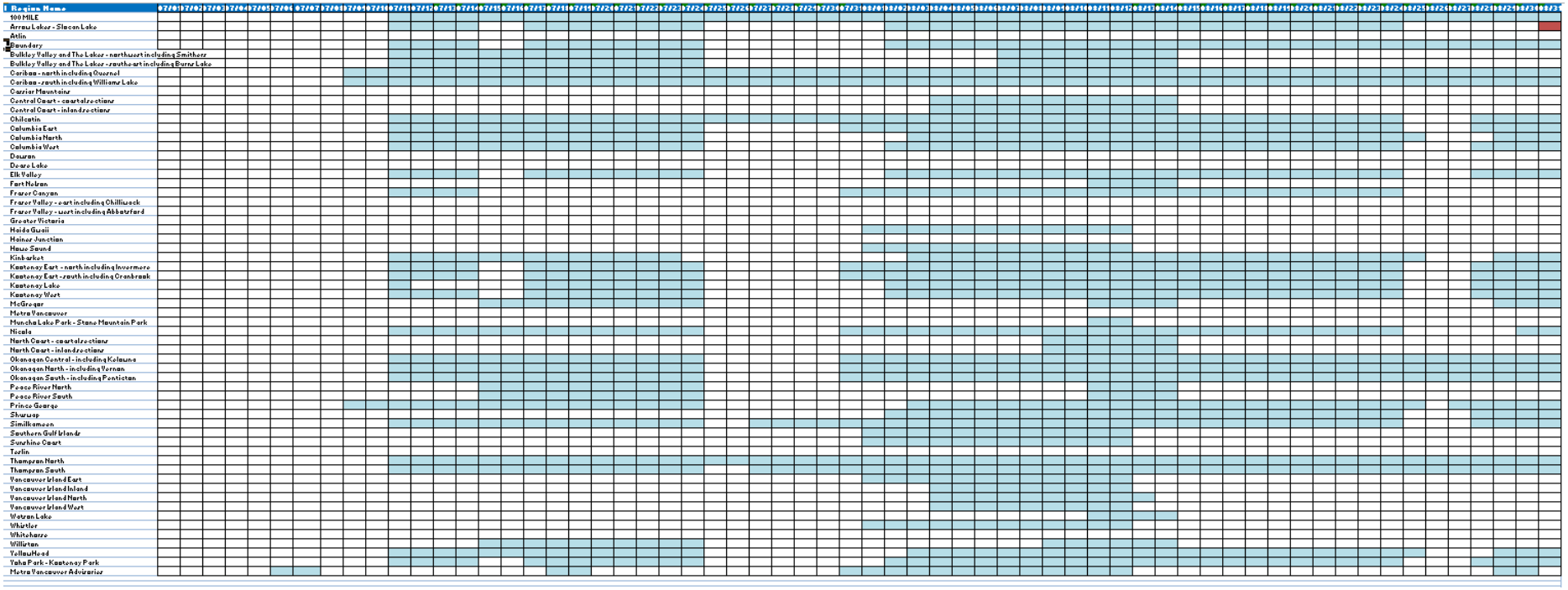
Expected change in burned area (top; 1000s ha) and forest fire suppression costs (bottom; in 100 000s $) under RCP 2.6 (blue) and 8.5 (red) emission scenarios



Hope et al., Wildfire Suppression Costs for Canada under a Changing Climate , PLoS ONE, 2016

How did this impact air quality forecasts?

July August

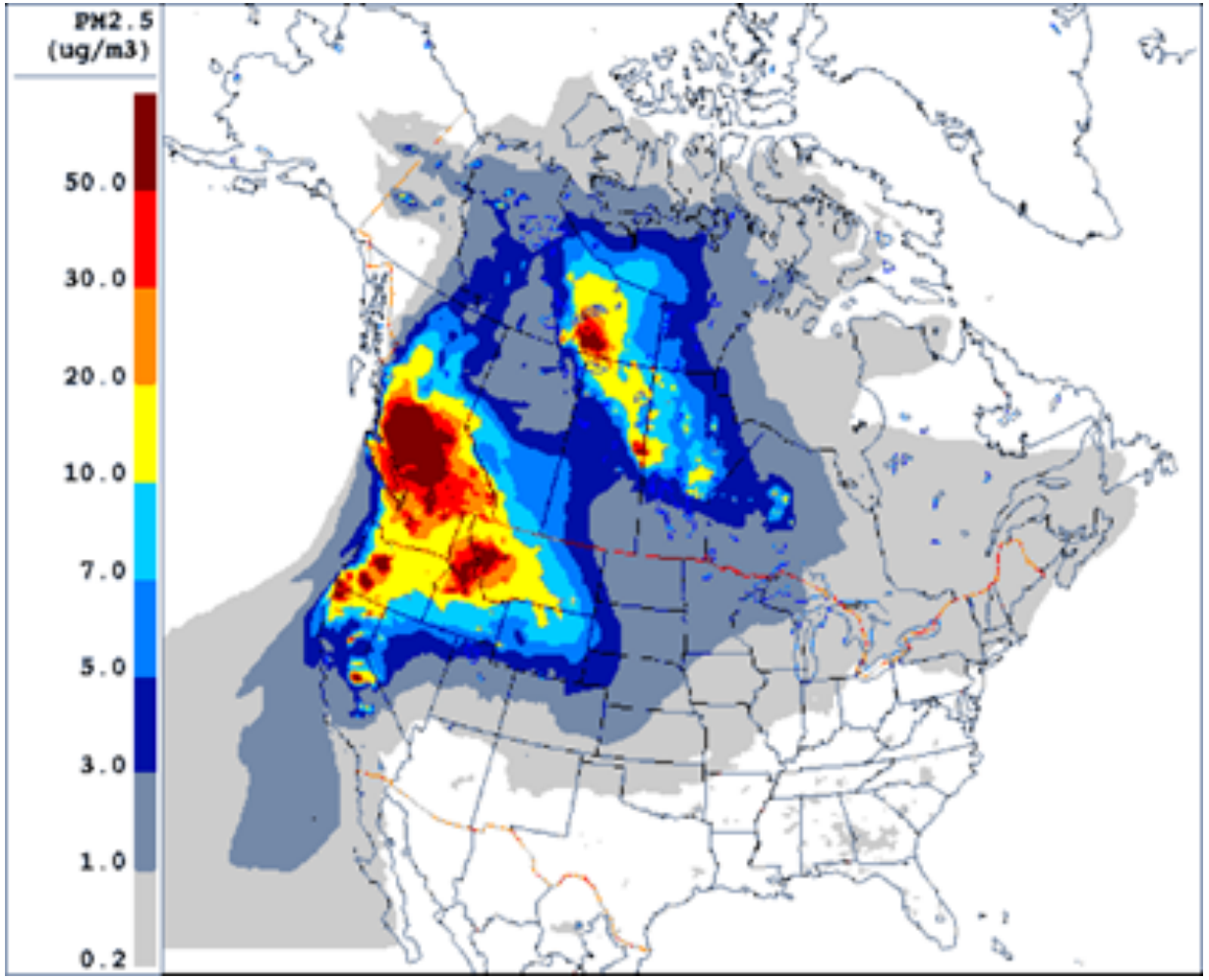


2017 Daily Air Quality Advisories (Smoky Skies Bulletins) by MSC Forecast Region

ECCC's FireWork System

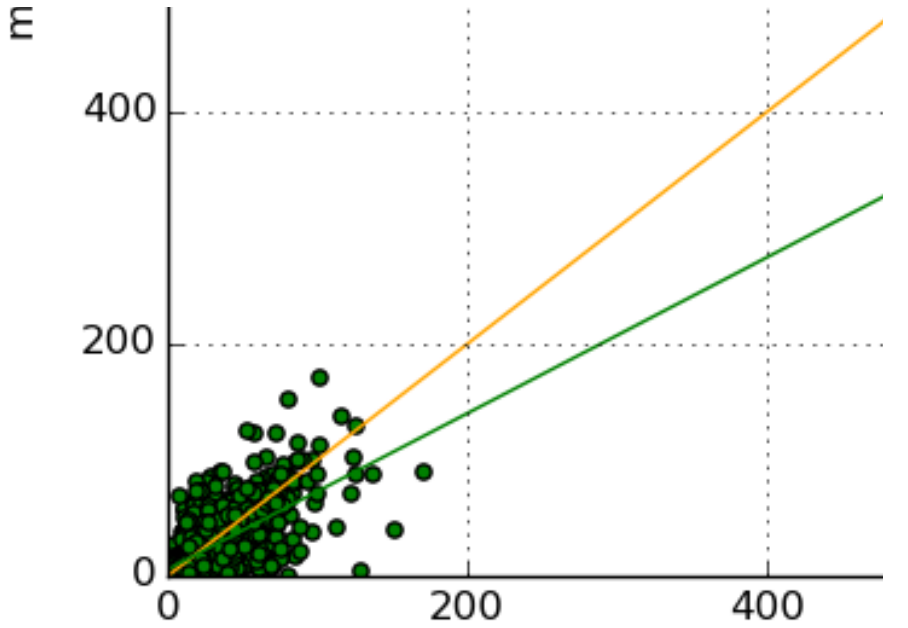
https://weather.gc.ca/firework

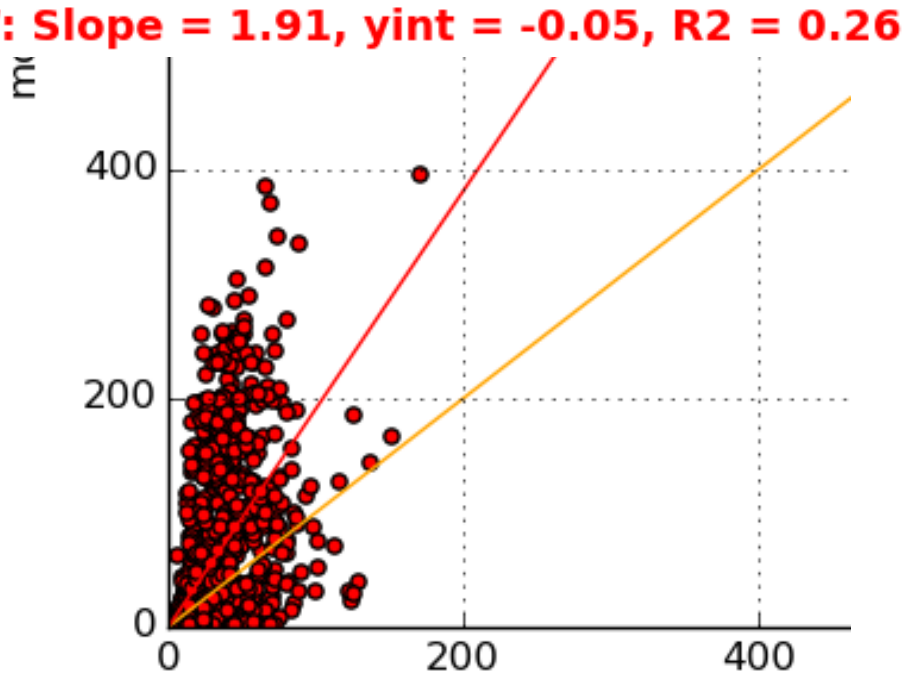
- Twice daily (00z/12z) during North American fire season Apr.- Oct.
- Near-real-time fire data from Canadian Wildland Fire Information System (based on NOAA/NASA satellite info.)
- Hourly wildfire emissions (PM, VOC, NOx, NH_3, CO, SO_2)
- Incorporated into the ECCC Regional Air Quality Deterministic Prediction System



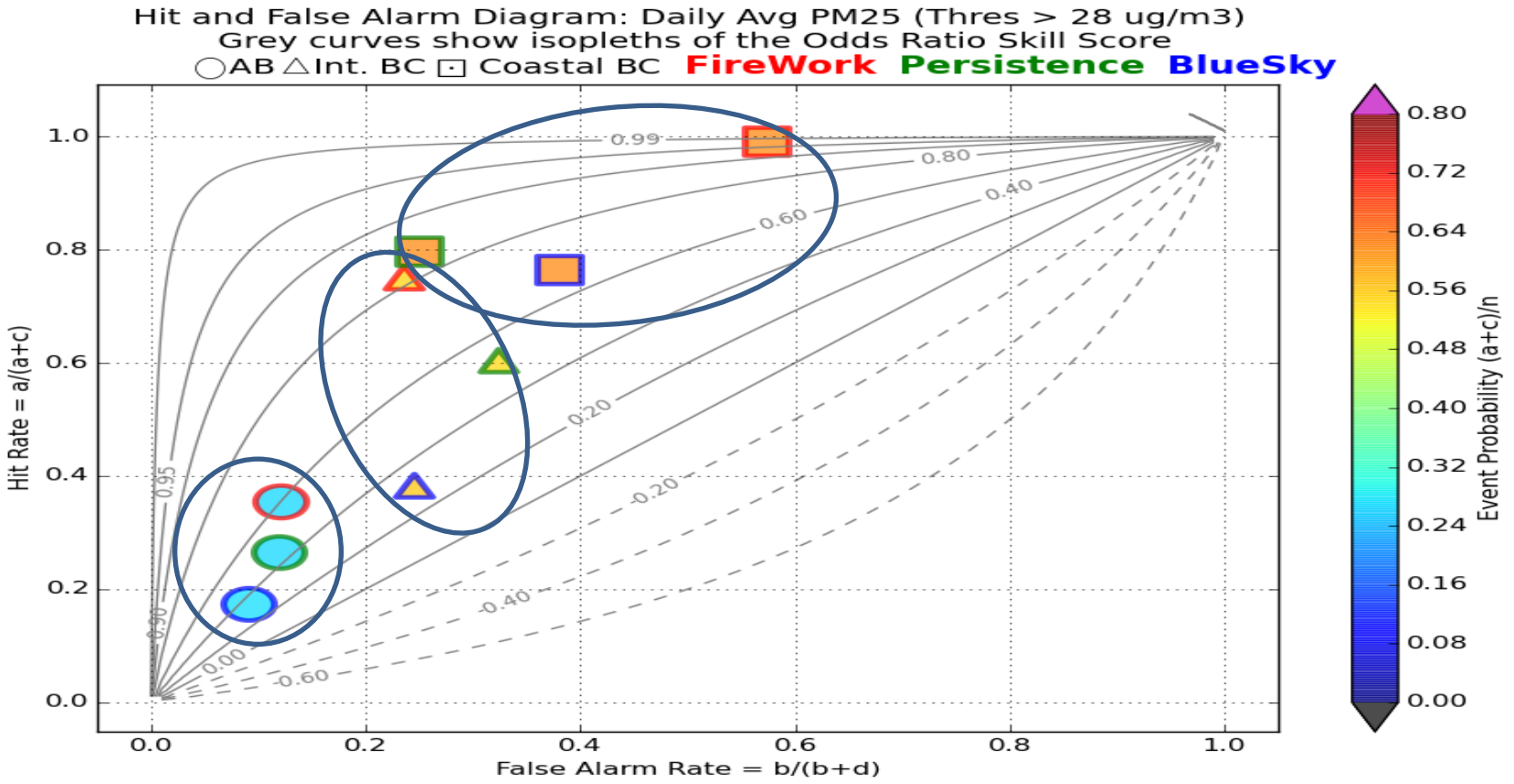
How well does FireWork predict wildfire PM25?

(it depends on your measuring stick)





Scatterplots of 24-hr PM2.5 during smoke impacted days (green: persistence model; red: FW)



☐ Coastal BC Observations

	Yes	No
Yes	Hit *(a = 206)*	False Alarm *(b = 74)*
No	Miss *(c = 2)*	Correct Neg. *(d = 55)*

FireWork

- FireWork predicted the most 'Events' and had the best scores in True Pos. & Miss Ratio

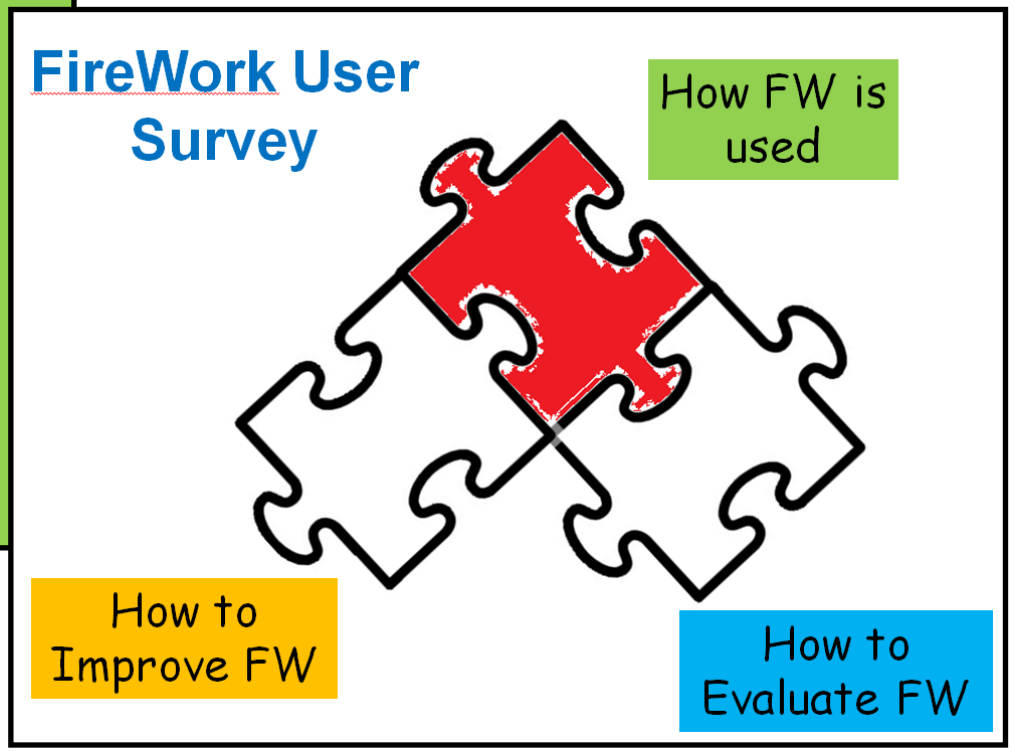
How to improve model performance and utility?

We need to find out:

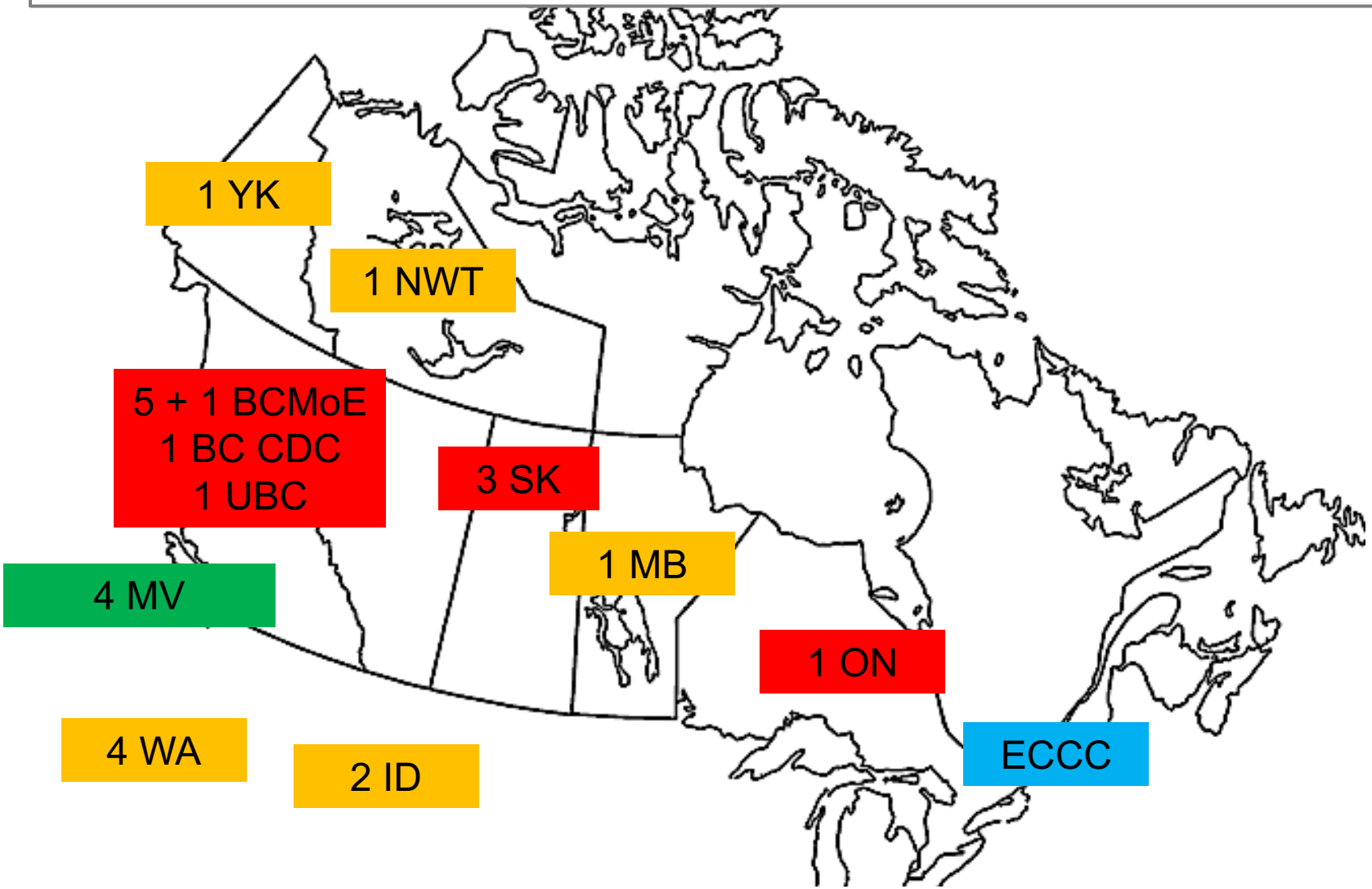
1. **How do forecasters make use of model output?**

Use results to:

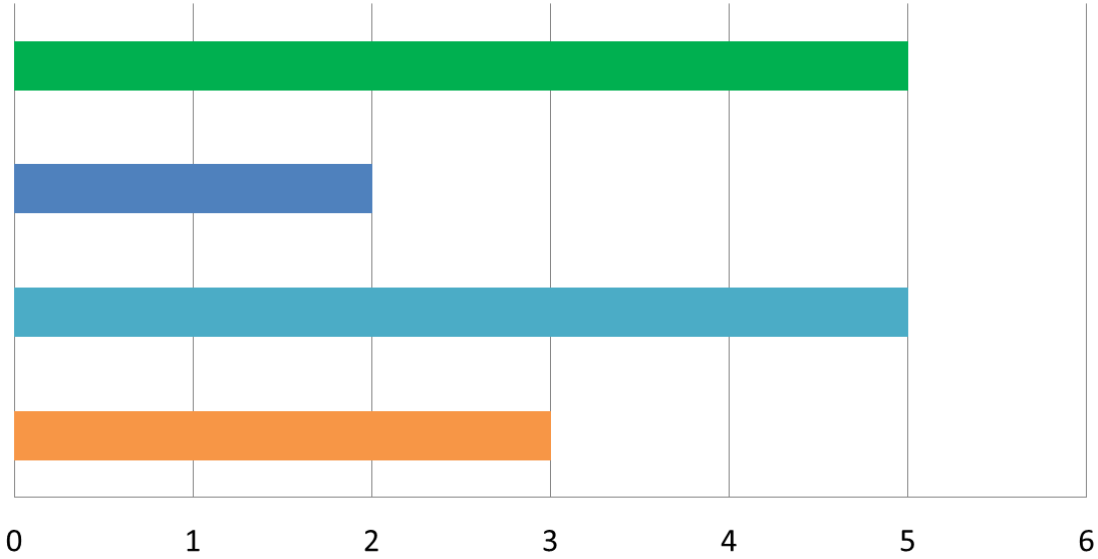
2. **Develop targeted model evaluation metrics**
3. **Better delivery of model guidance**



I. Informal meeting with MV
II. https://www.surveymonkey.com/r/ZKXHJG8 (original)
III. Teleconference with ECCC
IV. https://www.surveymonkey.com/r/FL7KKT9 (updated)

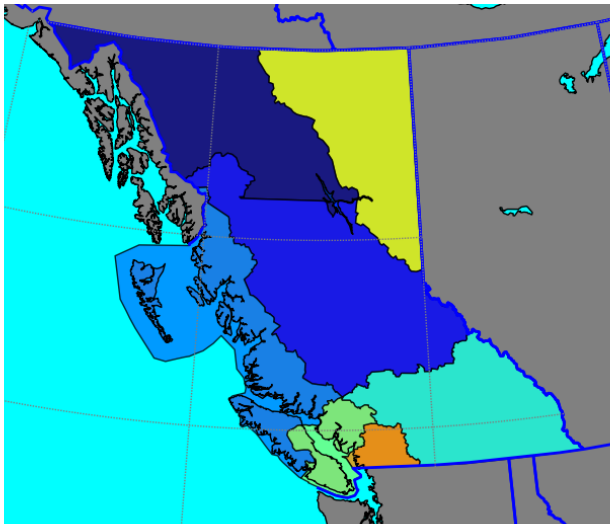


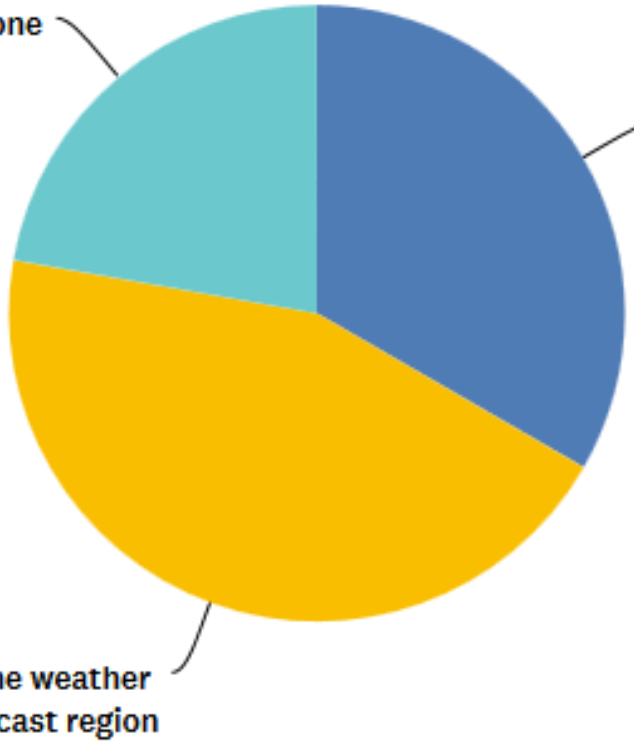
Q: How do you use model output (FW or other) in your decision making? Please check all that apply.

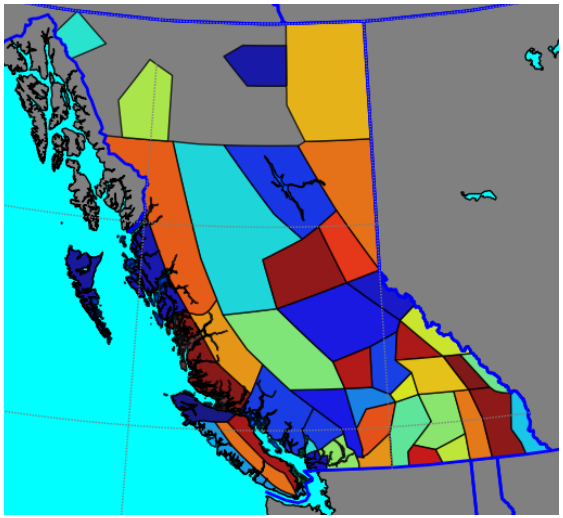


Model output is always used but not exclusively in decision making

Q: When looking at FW output, at what spatial scale is the most important?

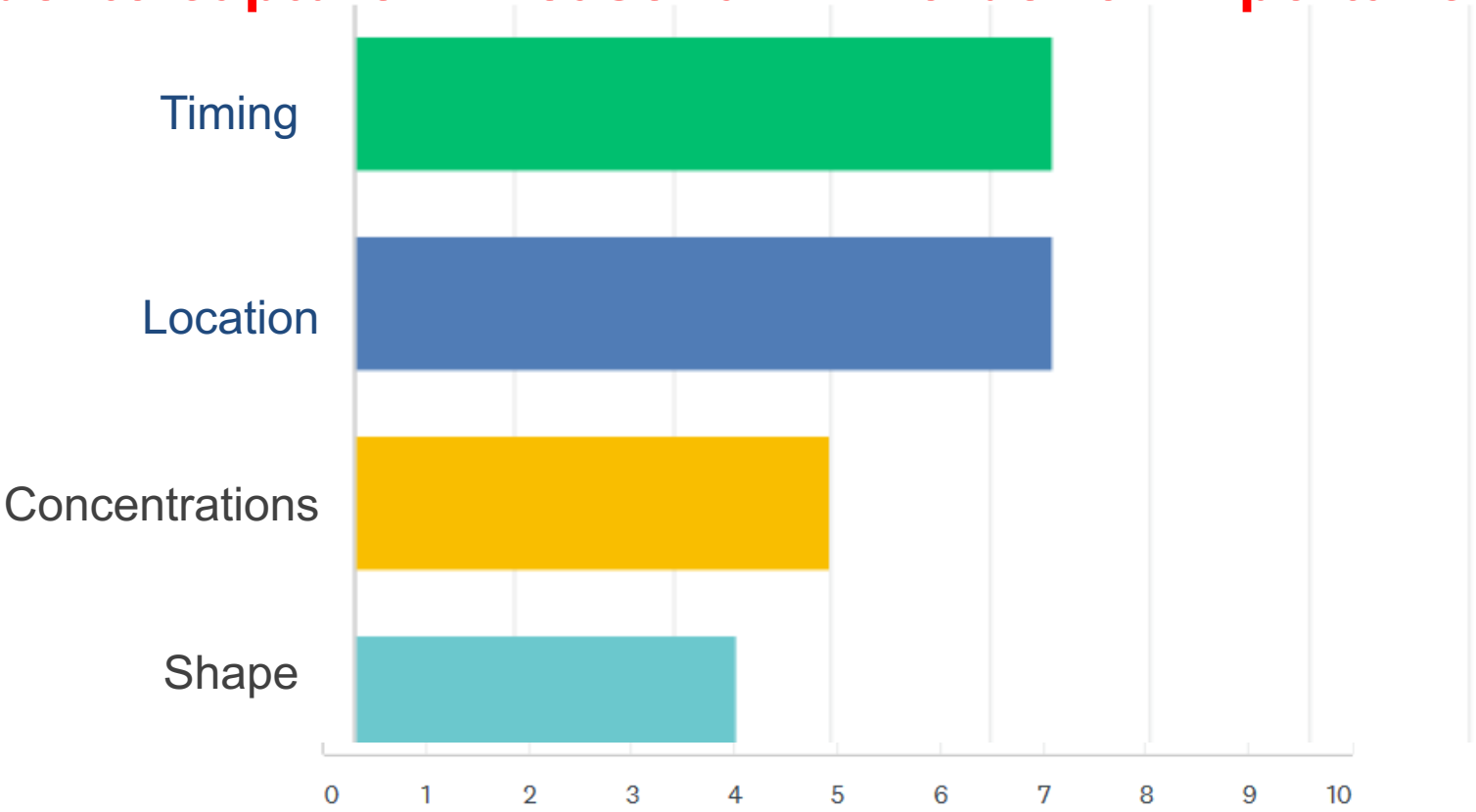






Mainly jurisdiction-based, but never at a monitor …

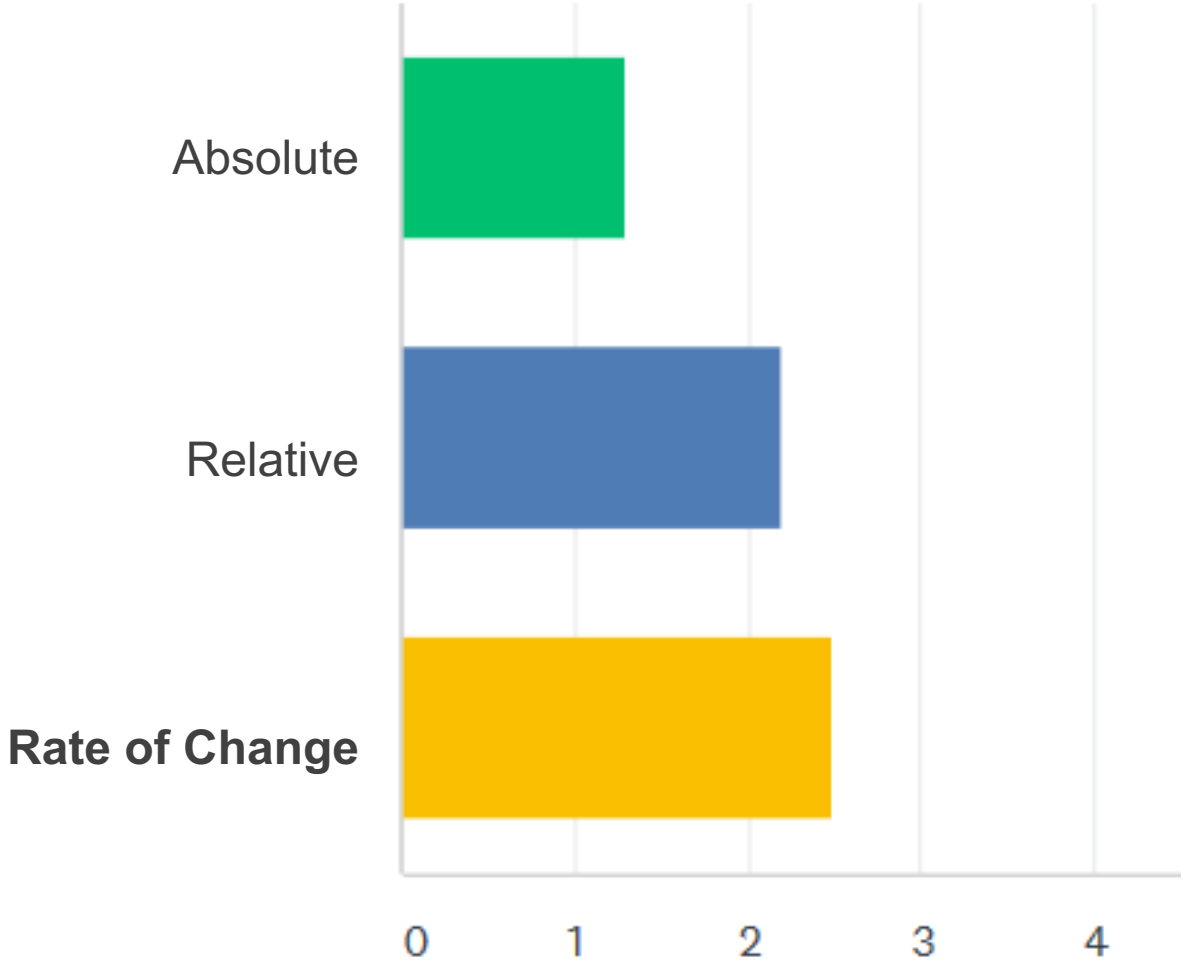
Q: When assessing the current/future AQ conditions during a forest fire event, what are the characteristics of the smoke plume that you would most want the model to capture? Please rank in order of importance.



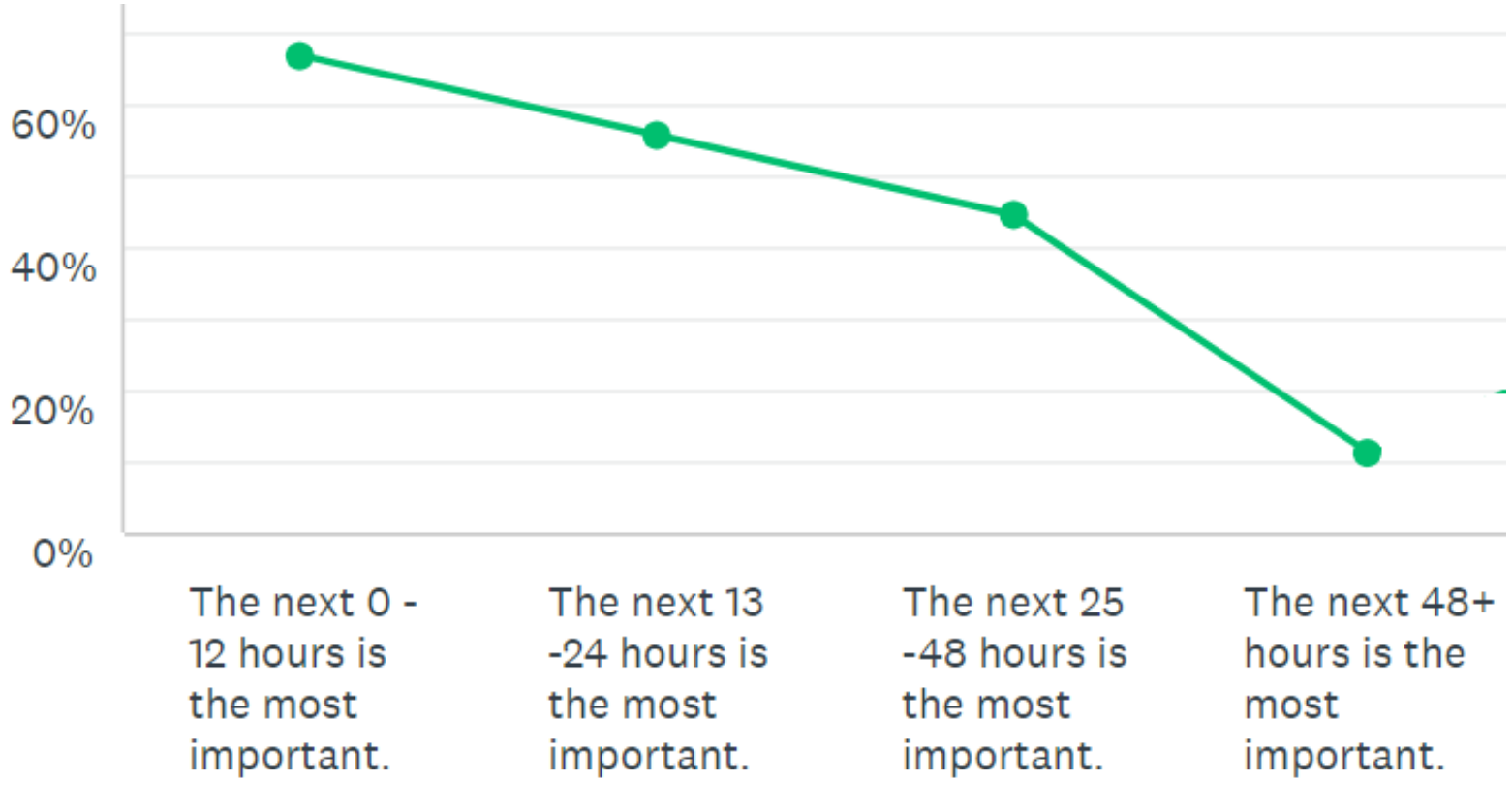
Characteristic ranking:

1) Timing & Location
2) Concentration & Shape

Q: Where should the model show the most skill: in predicting absolute, relative or changing PM2.5 concentrations? Please rank in order of importance.



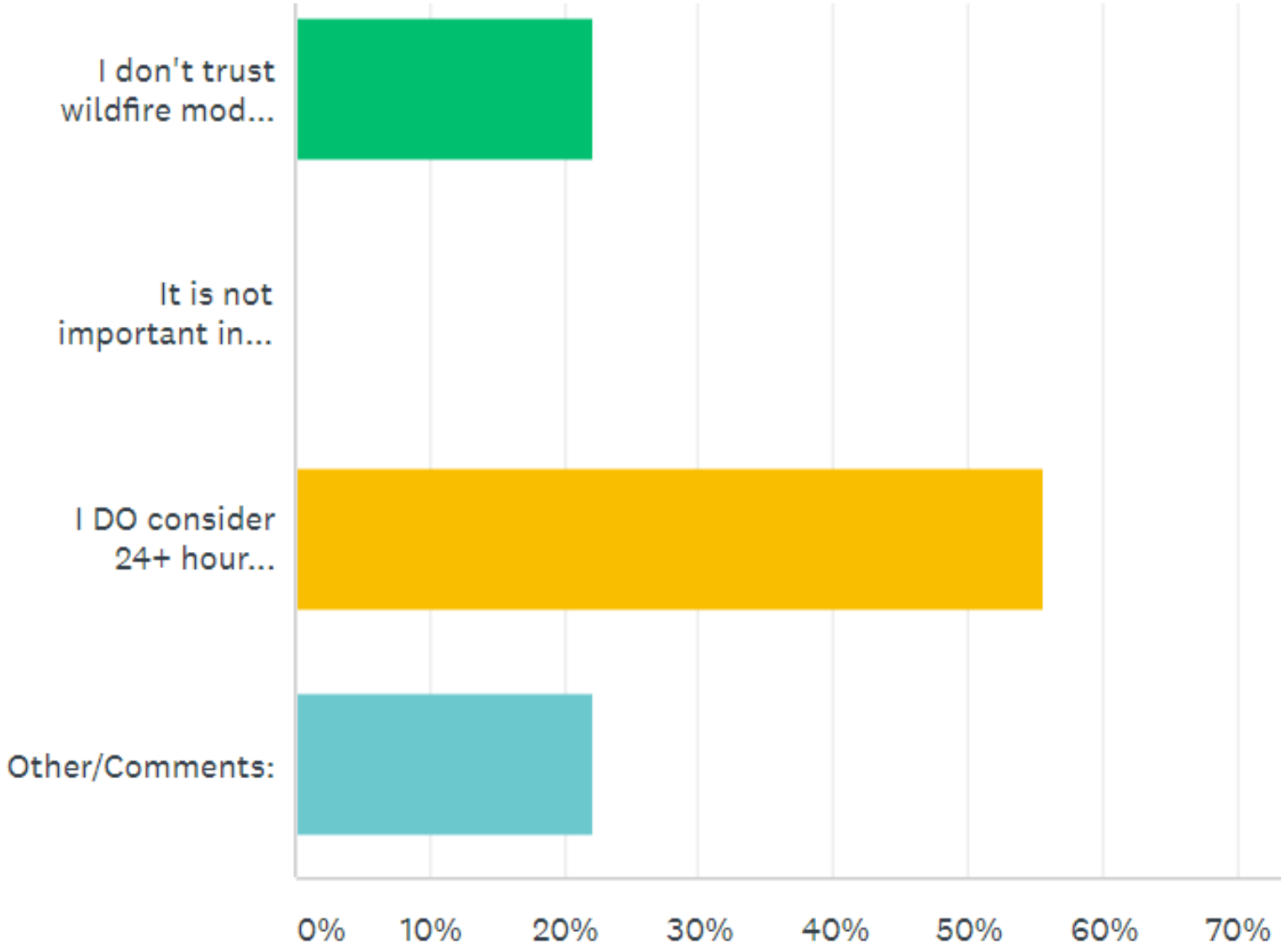
Q: What forecast lead time is the most important in your daily analysis during a forest fire event? Please rank in order of importance.



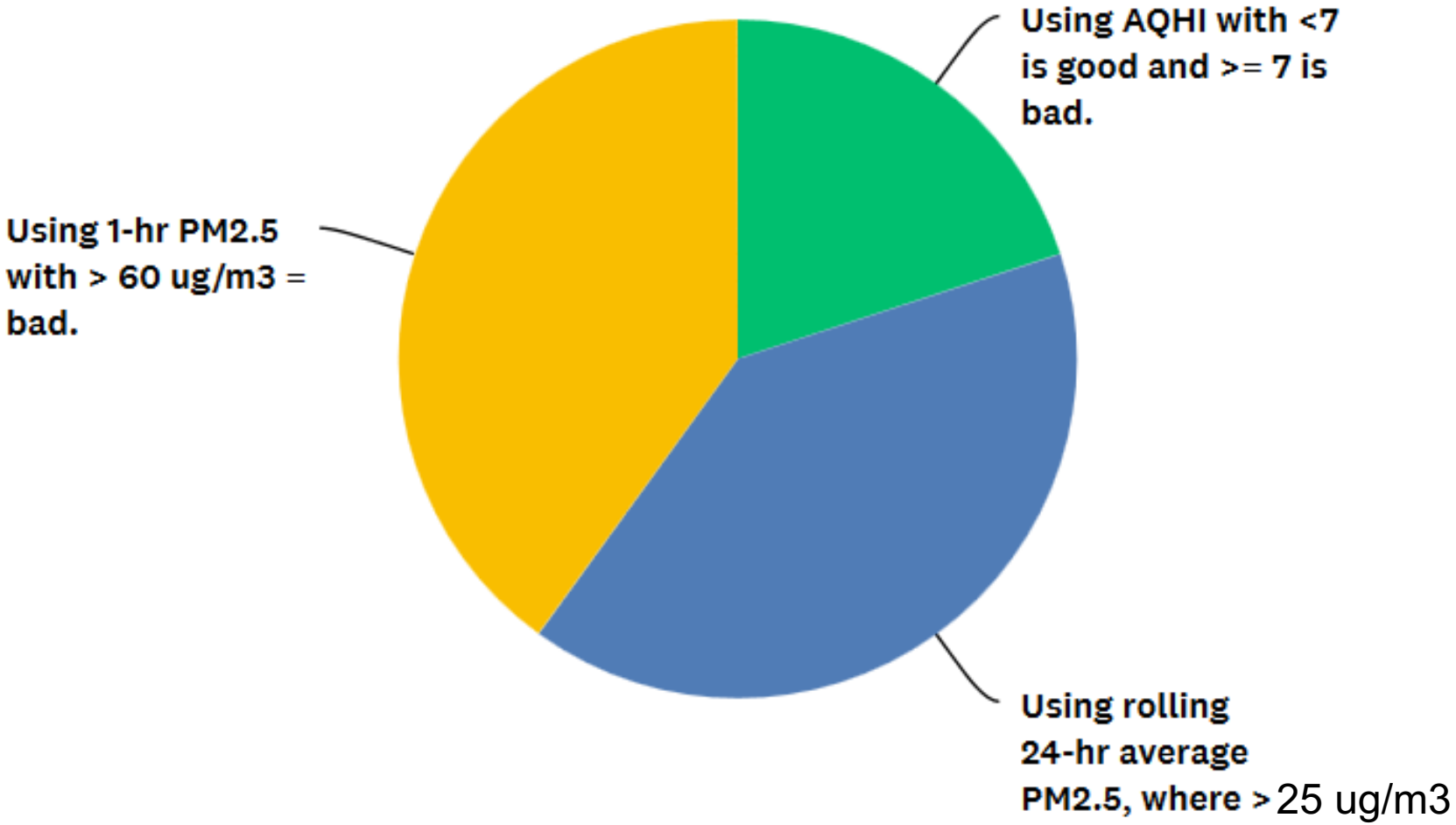
Most useful model guidance windows:

1) 0 – 12 hr
2) 12 – 24 hr
3) 24 – 48 hr

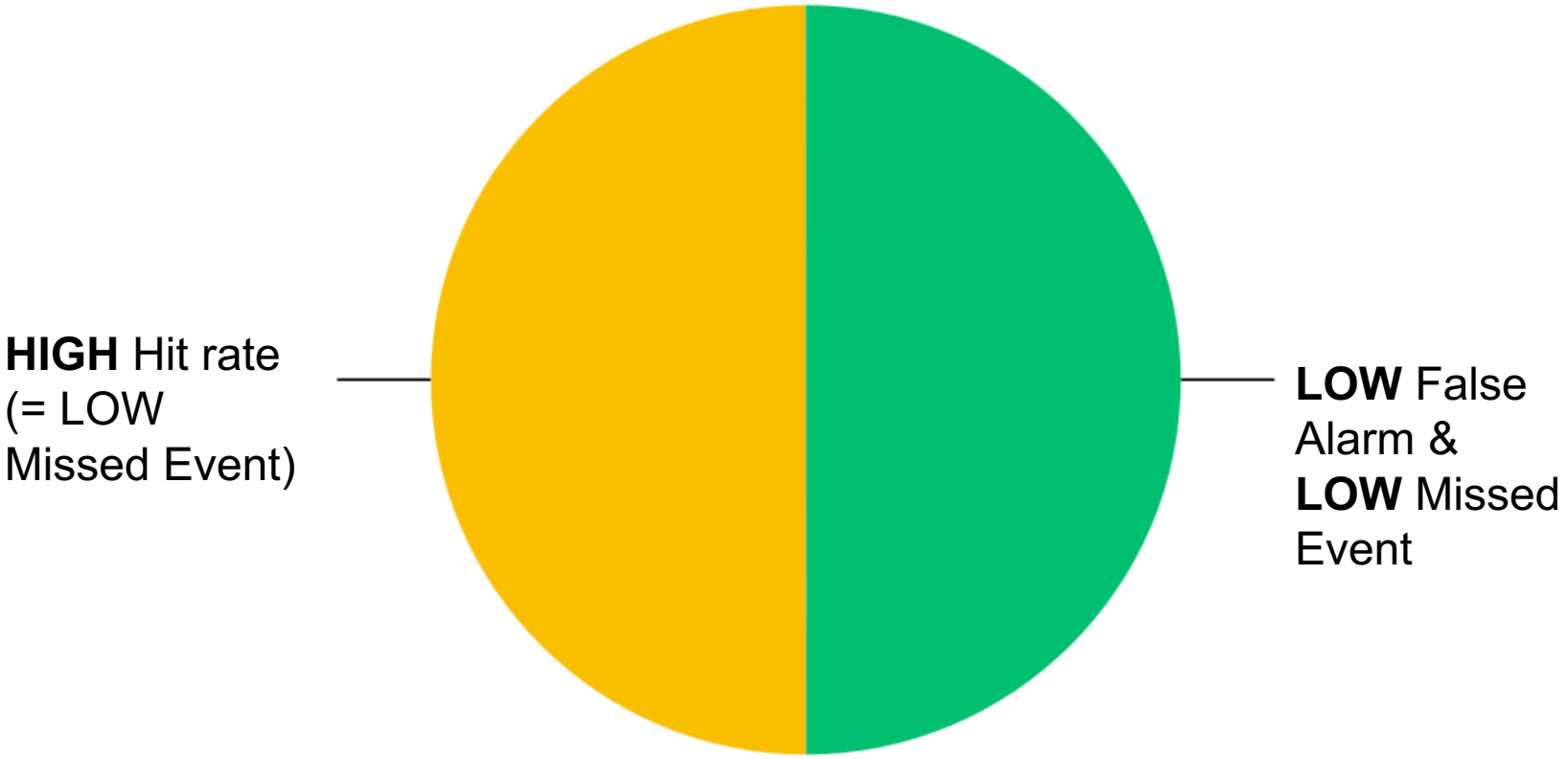
Q: I don’t consider longer range wildfire AQ forecasts (48+, 72+ hours) to be very useful because…



Q: To help evaluate model performance, what in your opinion is the best threshold and metric to characterize AQ during a forest fire event?



Q: It is important for a model to have a ….



Proposed contingency rubric

Prediction

Obs

	Yes	No
Yes	Hit	Missed Event
No	False Alarm	Correct Negative

24-hr PM2.5 = 25 ug/m3

	Yes	No
Yes	Hit	Missed Event
No	False Alarm	Correct Negative

$$Hit\ Rate = \frac{Hit}{Hit + Missed\ Event}$$

$$Threat\ Score = \frac{Hit}{Hit + Missed + FA}$$

Summary of Survey results:

- Model output: **always used but never exclusively**
- When issuing a forecast AQ meteorologists look at:
  - Variety of products (e.g. satellite, observations)
  - Variety of scales (e.g. municipal, forecast)
- Generally, AQ forecasters aren't interested at concentrations at the monitor-level per se, but like to gauge model behaviour using monitoring data
- Most important aspects of a wildfire plume to capture:
  - Timing & Location
- Least important:
  - Concentration & Shape

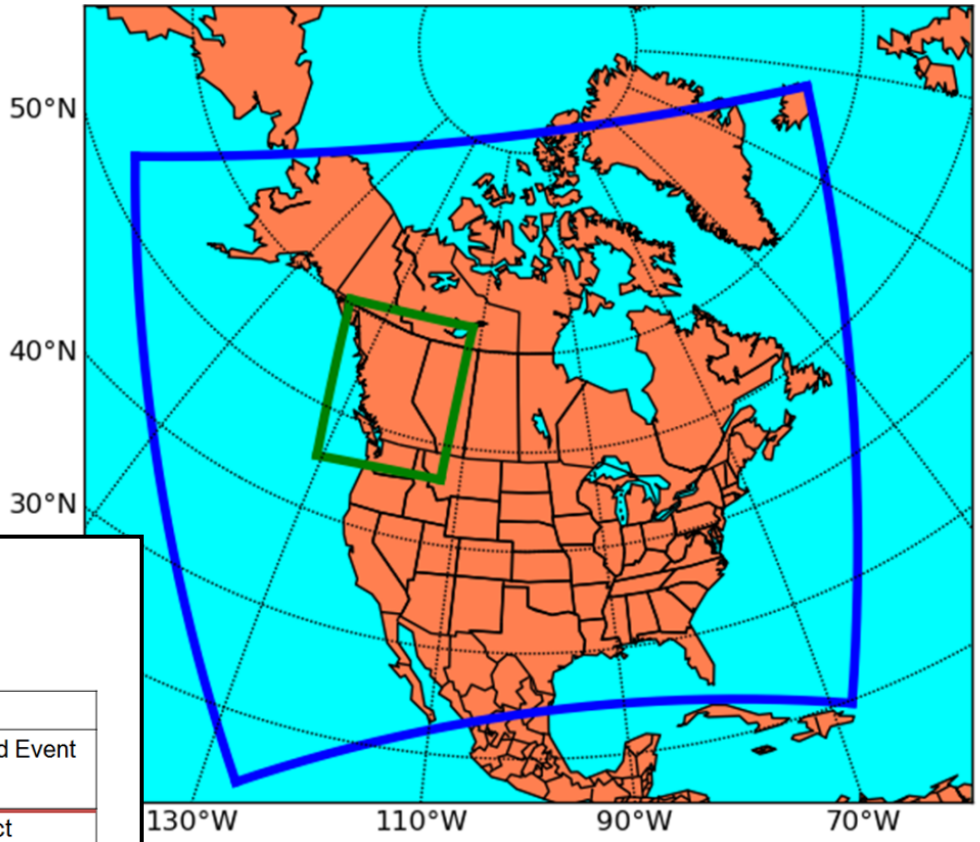
Retrospective modeling project objectives

- Re-run the 2017 wildfire season (JAS)
- Determine if forecasts are improved with:
  - **Higher model resolution**
  - **Better fire emission**
  - **Improved chemistry**
- Use evaluation metrics based on how model guidance is used/needed

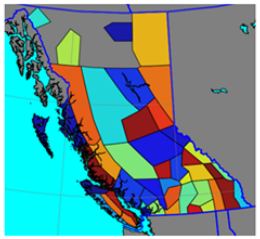
Scenario Matrix

	FEPS	CFFEPS
10 km	2 bin / 12 bin	2 bin / 12 bin
2.5 km	2 bin / 12 bin	2 bin / 12 bin

Model Configurations



Evaluation Metric



+

Prediction

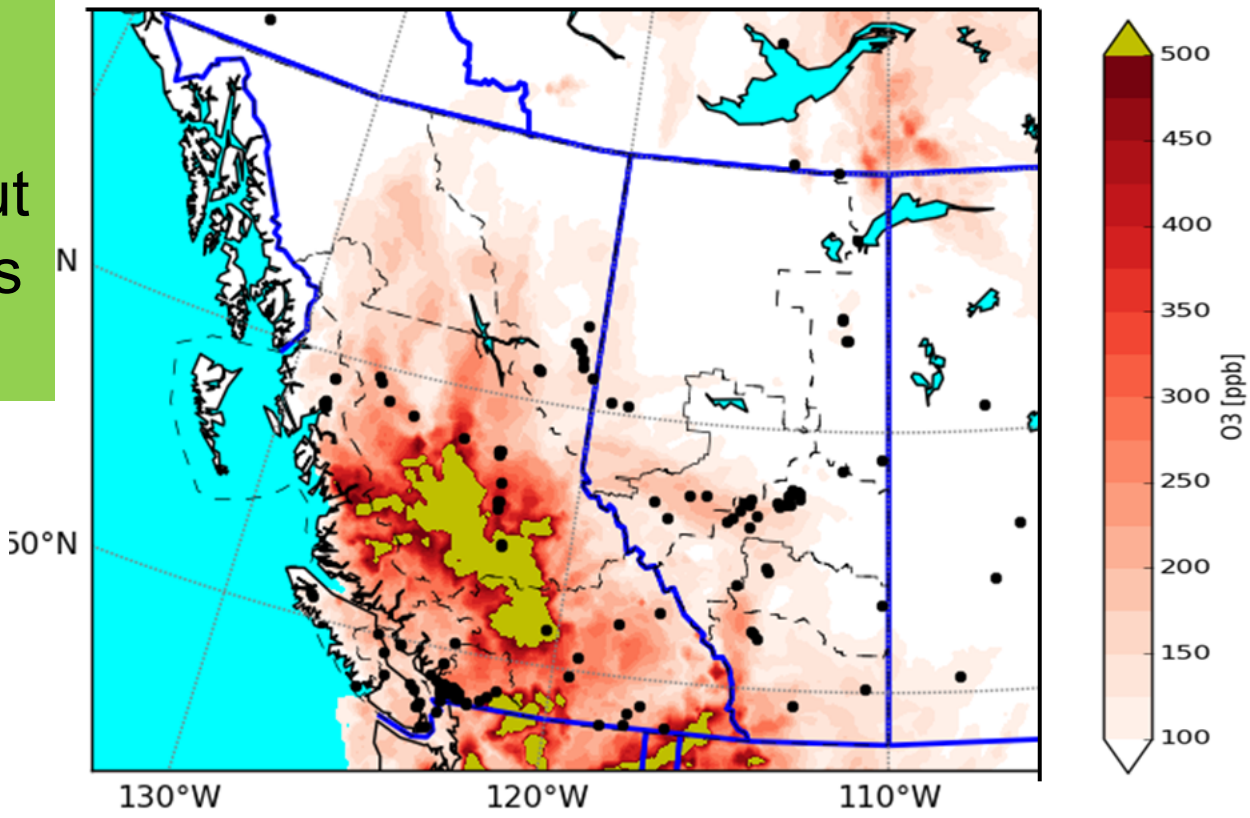
Obs		Yes	No
	Yes	Hit	Missed Event
	No	False Alarm	Correct Negative

@

Deterministic vs Probabilistic

- Could the mean of an ensemble forecast better capture plume shape?
- Expensive to run full chemistry – but how much value is it really adding?

2017 GM-FW maximum 1-hr ozone [ppb] predictions on smoke-impacted days



Conclusions

- FW model provide different information and model guidance is used differently than output from photochemical air quality models.
- FW shows skill when predicting onset/conclusion of events
  →These are exactly what forecasters are looking for
- How deterministic are the processes that lead to ambient PM25 from forest fire smoke?